PHYSIOLOGICAL AND BIOCHEMICAL EVALUATION OF GROUNDNUT CULTIVARS DIFFERING IN DROUGHT TOLERANCE

T.V.B. REDDY, J.S. PRAKASA RAO* AND K. VIJAYALAKSHMI

Department of Plant Physiology, S.V. Agricultural College, ANGRAU, Tirupati - 517 502

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SUMMARY

Six cultivars of groundnut were screened for relative drought tolerance based on the chlorophyll stability index (CSI), membrane stability index (MSI), peroxidase activity and ash content. CSI and ash content showed significant and positive correlation whereas MSI and peroxidase activity showed significant negative correlation with pod yield under moisture stress conditions. It is suggested that such traits should be utilized in future breeding programmes for drought tolerance. Among the cultivars TCGP-5, 6 and 10 performed better than JL-24, TCGS 320 and 596 throughout crop growth period under moisture stress conditions. Benzyl adenine (BA) seed treatment increased the growth rates and pod yields under moisture stress compared to water soaked seeds.

Key words: **Ash content, benzyladenine, chlorophyll stability index, drought tolerance, membrane stability index, peroxidase, yield.**

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is the important oil seed crop grown in India under rainfed conditions. Although this crop shows wide adaptability, but the yield is destabilized due to various biotic and abiotic stresses. Therefore, improvement for drought tolerance in groundnut is vital to stabilize the yield to previously unsuited regions and seasons.

Moisutre stress affects many physiological processes and photosynthesis is the most sensitive (Balasubramanyam et al. 1993 and Saxena et al. 1996). Moisture stress is reported to cause decrease in water potential and relative water content and increase in peroxidase activity (Tyagi *et al.* 1999, Mandal and Singh 2000). Reddy *et al.* (2000) observed higher ash content in tolerant groundnut genotypes as compared to susceptible ones. Chlorophyll stability and membrane stability has also been associated with water and high temperature stress tolerance in various crop plants (Raja Rajeswari 1995, Tyagi *et al.* 1999 and Talwer *et al.* 2002). The rapidity and easiness of these methods would provide the guidelines to the plant breeders to screen the genotypes for drought tolerance in groundnut. In view of the paucity of experimental data, the present study was conducted to identify genotypes for relative drought tolerance based on above parameters and to establish their relationship with yield.

MATERIALS AND METHODS

A field experiment was conducted during Rabi 2000-01 at wet land farm of S.V. Agricultural College, Tirupati, Andhra Pradesh (13°N, 79°E). The soil was red sandy clay loam in texture and medium in fertility status with 0.14% organic carbon, 190 kg available N, 24 kg available P_2O_5 and 147 kg available K_2O/ha with alkaline in reaction. Seeds of six contrasting cultivars of groundnut viz., TCGP-

*Corresponding authors

5, 6, 10, JL 24, TCGS 320, TCGS 596 were surface sterilized with 0.1% mercuric chloride and subsequently washed thoroughly with distilled water. Three treatments consisting of T_1-presoaking in water +no moisture stress (control); T_2 presoaking in 100 ppm benzyladenine (BA) for 6 hours + moisture stress at flowering (43-64 DAS) and T_3 - presoaking in water + moisture stress at flowering stage were tested in a factorial randomized design, replicated thrice. Moisture stress was created by with holding of irrigation from 43-64 DAS till the cumulative pan evaporation (CPE) values reaches 10.59 cms. Following this, the plots received regular irrigations similar like control plants. Sowing was done at a spacing of 22.5 X 10 cm which accommodates a population of 44 plants m^{-2}. A basal dose of 20 N, 40 P_2O_5 and 40 K_2O kg/ha was applied in the form of urea, SSP and MOP respectively. The remaining 10kg N combined with gypsum (500 kg)/ha was top dressed at 50 per cent flowering stage. Five plants from each plot were collected randomly for estimating the physiological and biochemical parameters, *viz.* relative water content (Smart 1974), peroxidase activity (Sadasivam and Manickam 1996) and ash content (Masle *et al.* 1992). Chlorophyll stability index (CSI) was estimated by the method described elsewhere (Sairam 1994).

Membrane stability index was estimated by recording the electrical conductivity (EC) of ions leached in distilled water from 2 cm leaf discs subjected to 55°C temperature treatment for 1h followed by incubation at 10°C for 24 h and again after boiling the same for 15 min. The per cent injury was determined according to Blum and Ebercon (1981). Yield components and yield were recorded at harvest while yield stability index (YSI) was calculated following Lewis (1954).

RESULTS AND DISCUSSION

The perusal of data (Table 1) indicated significant decrease in relative water content (19.3%), chlorophyll stability index (25.6%) and ash content (10.7%) under moisture stress compared to control plants. This might be due to decrease in internal water content of protoplasm and loss of chlorophyll a:b ratio which might be the result of premature senescence of leaves (Reddy *et al.* 2000). The susceptible genotypes JL 24, TCGS-320 and 596 exhibited lower values, on the other hand the tolerant genotypes TCGP-5, 6 and 10 maintained comparatively higher values under stress as well as exhibited lower reduction under stress. Relatively higher RWC and CSI have been reported in drought tolerant cultivars of wheat (Sairam 1994 and Martin *et al.* 1997). The reduction of above characters was more with untreated plants compared to BA pretreated plants indicating beneficial effect of BA treatment to over come inhibition of chlorophyll synthesis caused by moisture stress (Narendra Reddy *et al.* 1997).

Membrane stability index or percentage of injury was significantly high with moisture stressed plants compared to control. Lower percentage of injury was recorded with tolerant cultivar TCGP-6 closely followed by TCGP-5 and maximum MSI with susceptible cultivar TCGS-320. Premchandra *et al.* (1990) have reported that cell membrane stability is an indicator of drought tolerance. Higher percentage of injury under water stress have also reported in susceptible genotypes in wheat (Sairam *et al.* 1997). However, BA treated seed maintained lower per cent of injury values than untreated seed which might be due to beneficial effect of BA in providing better biochemical defence mechanism against free radicles generated due to moisture stress or mechanism for reducing even their generation or both (Leibler *et al.* 1986).

Peroxidase is an antioxidant enzyme which exhibits higher activity under water and high temperature stress. In this study the peroxidase activity of groundnut plants was significantly increased (28%) due to imposition of stress compared to control plants. Mandal and Singh (2000) have reported that peroxidase may prevent the degradation of membrane integrity of the cells against the radicles formed under moisture stress. The peroxidase activity due to moisutre stress was further improved with BA seed treatment (50%) compared to untreated seed. The tolerant genotypes TCGP-5, 6 and 10 showed (30%) increase in peroxidase activity under water stress, while susceptible genotypes JL 24, TCGS-320 and 596 showed negligible increase of peroxidase activity under water stress. Similar reports regarding differences in stress tolerance of cultivars was made by Jha and Singh (1997) and Mandal and Singh (2000).

Moisture stress decreased the pod yield (Table 2) significantly primarily due to reduction in number of pods per plant (41.2%) followed by 100 kernel weight (22.5%)

Table 1. Physiological and biochemical parameters of different groundnut cultivars as influenced by moisture stress and benzyladenine (BA) seed treatment during crop growth period.

Treatment	Relative water content (%)		Chlorophyll stability index (%)		Membrane stability index (%)		Peroxidase activity (units/liter)		Ash content %	
	57	71 DAS*	57	71	57	71	57	71	57	71
T_1 - Control (soaked in water + no moisture stress)	82.4	85.3	82	84	30.6	30.9	222.7	217.8	7.5	7.5
T_2 - (soaked in B.A. + moisture stress at flowering stage)	73.7	80.4	70	79	36.5	33.4	335.0	285.6	7.3	7.2
T_3 - (soaked in water + moisutre stress at flowering stage)	67.4	72.1	61	69	40.2	37.5	286.1	225.5	6.7	6.6
SEM ±	0.9	0.9	1.0	1.0	0.4	-	2.9	1.8	0.1	0.1
CD at 5%	2.7	2.8	2.0	3.0	1.25	NS	8.2	5.1	0.3	0.3
CULTIVARS										
TCGP - 5	80.3	83.8	76	83	32.8	31.1	286.9	280.1	7.5	7.4
TCGP - 6	81.8	84.8	79	87	22.5	20.3	289.4	281.4	7.8	7.5
TCGP - 10	79.6	82.7	75	81	33.2	32.0	282.9	276.5	7.6	7.4
JL - 24	74.5	79.9	74	76	37.6	37.5	251.9	229.8	7.1	7.1
TCGS - 320	74.4	80.7	73	76	38.1	37.0	254.3	231.9	7.0	7.1
TCGS - 596	75.1	79.6	73	76	38.1	37.7	245.9	225.5	7.2	7.1
SEM ±	1.2	1.2	1.0	1.0	0.5	0.6	3.5	2.2	0.1	0.1
CD at 5%	3.3	3.4	3.0	3.0	1.5	1.8	10.1	6.2	0.3	0.4

DAS*= Days after sowing

Table 2. Effects of moisture stress and benzyl adenine (BA) seed treatment on yield and its components of different groundnut cultivars at maturity.

Cultivars (v)	Pod yield ($g\ m^{-2}$)			Pod number/ plant			100 kernel weight (g)			Yield stability
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	index (%)
TCGP - 5	340.01	310.49	289.49	21.05	20.06	18.88	37.15	33.42	28.91	75.71
TCGP - 6	365.65	345.92	328.85	23.18	21.77	20.73	37.95	35.56	30.44	82.21
TCGP - 10	325.28	290.85	267.88	21.45	19.58	18.82	36.12	31.97	27.61	71.90
JL - 24	270.45	220.68	188.68	19.91	19.19	18.38	34.56	27.37	24.92	55.16
TCGS - 320	254.48	218.75	190.89	20.85	19.90	19.61	32.25	30.89	25.77	57.31
TCGS - 596	170.24	130.28	98.95	19.01	18.74	18.46	31.75	25.94	24.88	44.47
	T	V	TXV	T	V	TXV	T	V	TXV	-
SEM ±	3.16	3.87	NS	0.41	0.50	NS	0.60	0.74	NS	-
CD at 5%	9.02	11.05	-	1.17	1.44	-	1.73	2.11	-	-

T_1 = Control - water soaked + no moisture stress; T_2 = Soaked in BA + moisture stress at flowering stage; T_3 = Soaked in water + moisture stress at flowering stage and number of seeds per pod (20.4%). In addition the reduction in pod yield with BA treated seed under moisture stress was less (15.8%) than the untreated plants (21.1%). Beneficial effect of BA on seed yield (Sivakumar and Virendranath 2000) has also been reported. The genotypic variation to drought were also evident in this study. Tolerant genotypes showed significantly higher pod yield and yield components under moisture stress compared to susceptible ones. Further, variation in yield stability index (YSI) was observed among the cultivars under moisture stress. The susceptible genotypes showed lower values than the tolerant genotypes indicating that tolerant genotypes have the ability to with stand drought and gives higher yield under moisture stress conditions. Moreover, CSI (0.59) and ash content (0.70) were positively and significantly correlated, while MSI (-0.78) and peroxidase activity (-0.65) was negatively and significantly correlated with pod yield under moisture stress conditions (data not shown). Thus the perusal of results shows that BA seed treatment improves the metabolic activity and drought tolerance capacity of the cultivars during moisture stress conditions. Therefore, for proper evaluation of tolerance/susceptibility of a given cultivar, either membrane stability index or chlorophyll stability index and biochemical parameters, either peroxidase activity or ash content should be examined.

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